EE 2274
Pre-Lab for Experiment # 3
RC and Op Amp Circuit
Completed Prior to Coming to Lab

Part I: RC Circuit

1. Design a high pass filter Fig. 1 which has a -3dB point at 1 kHz. Use a .1ufd capacitor. $f_b = 1/2\pi RC$

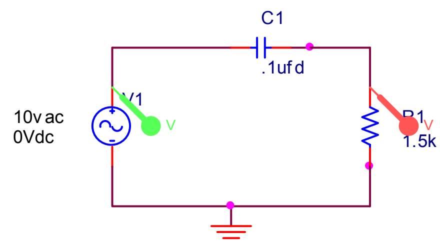

Fig. 1

2. Use PSpice to perform an AC sweep of your designed circuit from 10Hz to 10kHz with 10 points per decade. You will need to use 10 VAC , 0 DC as your voltage source. Print out the AC sweep and label the -3dB point. (hint: After you do the AC Sweep then change graph and label to dB by "adding trace" and using the formula dB= 20 $\log_{10} V_0/V_{in}$. $V_0 = V_{1..5kohm}$, $V_{in} = V1$)

3. Exchange C1 with R1 (Fig. 2) and measure the voltage across C1 and V1 as you did above. Do the sweep and change the graph to dB as in 2. What type of filter? ans:

   ____

   Label and turn in both graphs.

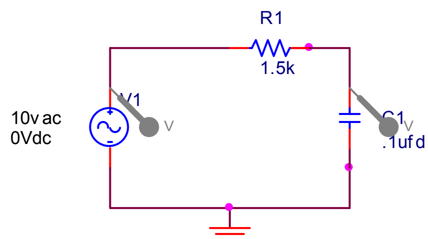

Fig. 2

Part II: Op-Amp Circuit

1. Simulate an inverting amplifier circuit using a uA741 Op amp.
   a. The closed loop voltage gain (Av = vo/vi) should be designed to be -10.

b. Choose resistor values for R1 and R2 between 500Ω-20kΩ from the list of 5% nominal resistor values.
c. The positive and negative voltage supplies, V+ and V-, should be set to 12v and -12v, respectively.
d. The input voltage source should be a part called VSIN. Set the DC offset voltage, VOFF, to 0V; the amplitude of the sinusoidal voltage source, VAPML, to 200mV, and the frequency of the voltage source, FREQ, to 1k (which is equal to 1000 Hz).
e. Put two voltage markers into the circuit. One should be right after Vi and the other should be at the output of the uA741 Op Amp. Graphing both the input signal and the output signal allows comparison of what the circuit did to the input signal.
f. Plot a transient analysis to confirm the gain of -10. Print out this transient to be turned in.
g. Using the cursors, find the exact AC gain of the op amp.

*NOTE: Pay close attention to the orientation of the op-amp in figure 3-1. The op-amp has been flipped vertically to make the wiring easier. The voltage source V3 has also been flipped.

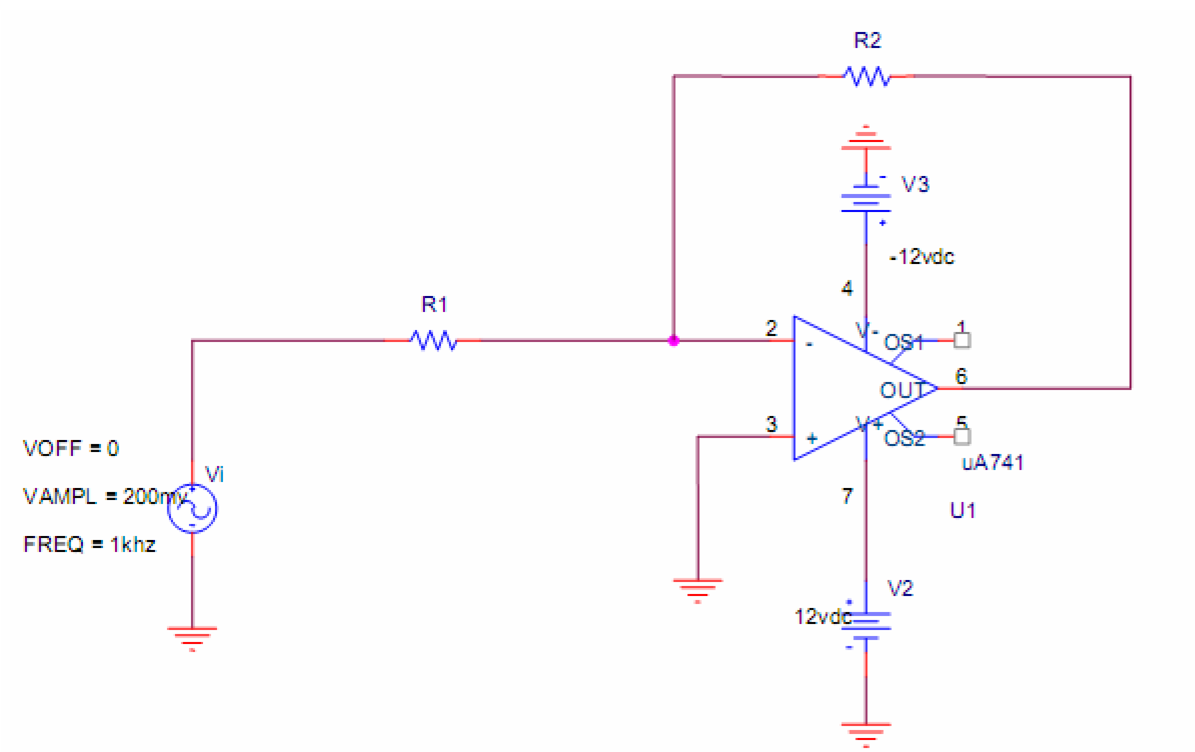

Figure 3-1: Inverting op-amp. Note that the op-amp has been vertically flipped as well as the DC source V3.

2. Run the following simulations:
   a. DC Sweep

i. Create a new simulation profile.
ii. Select ‘DC Sweep’ from the “Analysis type” pull-down box.
iii. Type the input voltage source label in the box next to the field “Name:”. Note that this would be Vi in the drawing above, but this will not be the default name of the input voltage source in your PSpice drawing. The start value should be 0V and the end value should be 2V. Ensure that a linear sweep will be performed. Select a reasonable increment to obtain a smooth curve.
iv. Click OK in the Simulation Setup window.
v. Run the simulation. Another window should open and a plot of the output voltage versus the input voltage should appear. This graph is commonly known as the voltage transfer function. Use this plot to answer the questions located on the Pre-Lab Answer sheet
vi. Print a copy of the graph.

b. AC Sweep
i. Change your input voltage source from VSIN to VAC. Set the AC voltage to 1V.
ii. Go to the “Edit Simulation” window.
iii. Select ‘AC Sweep’ from the “Analysis type” pull-down box.
iv. Ensure that a linear sweep is selected.
v. The start frequency should be 1k and the end frequency should be 1000k. Select a reasonable number of total points to obtain a smooth curve.
vi. Click OK Simulation Setup window.
vii. Run the simulation. Another window should open and a plot of the output voltage versus frequency should appear. Use Trace → Cursor → Display . To determine the -3dB frequency point.
viii. viii. Print a copy of the graph.

Pre-Lab 3 Answer Sheet:

Part I:

1. What value of R gave a -3dB point at 1 kHz? __________
2. Amplitude (dB) Fig 1 Calculated _____ PSpice_____ % ___ Type _____
3. Amplitude (dB) Fig 2 Calculated _____ PSpice_____ % ___ Type _____
4. Explain why in Fig. 1 we measured across R, then in Fig. 2 across C, and had a different type of filter?

(hint: X_c= -1/2πfC)

Part II:

1. What is the AC gain of the op amp? __________
2. What is the DC gain of the op amp? __________

At what input voltage V_i does the output voltage V_o reach a maximum?

V_i = __________ V_o = __________

Why does the output voltage hit a maximum at this value?

2. b. vii. At what frequency does the output voltage V_o reach the -3dB point? __________

At what frequency does V_o equal the input voltage V_i? __________

Lab Exercise
Experiment # 3
RC and Op Amp Circuit

Part I:

1. Build the high pass filter designed (Fig. 1) in the Pre-Lab
2. Run an AC sweep from 10Hz to 10,00Hz with a waveform amplitude of 10vac. Set the driving device to be the Agilent 33120A function generator and the reading device to be the Agilent 34401A multimeter. Use 20 steps per decade.
   a. Save the waveform to the buffer and go to the buffer menu. Select the waveform to save it, and then use the cursors to identify the -3dB point. How close is this from the design value? What could cause this error?
   b. Print out plot with log-x and dB-y axis
   c. Measure the exact value of the capacitor using the capacitance meter and measure the exact value of your resistance.
   d. Recalculate the -3dB point using the measured capacitance and resistance value.
3. Build the low pass filter designed (Fig. 2) in the Pre-Lab.
4. Run an AC sweep from 10Hz to 10,000Hz with a waveform amplitude of 10vac. Set the driving device to be the Agilent 33120A function generator and the reading device to be the Agilent 34401A multimeter. Use 20 steps per decade.
   a. Again, use the cursors to identify the -3dB point.
   b. Print out the plot with log-x and dB-y axis

Part II:

1. DC Sweep:
   a. Build the inverting amplifier that you designed in the pre-lab. Select the DC sweep from the lab workbench software. Sweep parameters: Initial 0V, end voltage 2V, step voltage 50mv. Use the update parameters to set the values. Configure the multimeter for DC volts. Save your waveform to the buffer to be printed out and turn in with your lab data.
2. AC Sweep:
   a. Run an AC Sweep from 100Hz to 100,000Hz with a waveform amplitude of 200mV with 20 sweeps per decade.
   b. Print the plot with a log-x and dB-y axis.
   c. What frequency is the -3dB point? How does this compare to PSpice?
3. Transient:
   a. Using the function generator, select a sinusoid with an amplitude of 100mV (200mV peak to peak) and a frequency of 1kHz.

b. Using the oscilloscope, measure the maximum output voltage in the positive and negative halves of is cycle.
c. Adjust the amplitude of the function generator until you observe clipping of the wave form.
d. Do a scope capture to be turned in with your lab to show clipping
e. At what value does clipping occur? Why?
f. How does this compare to PSpice?

Data Sheet
Experiment #3
RC and Op Amp Circuit

Part I:

2. a. -3dB point of high pass filter. ____________

   b. % error from PSpice ____________

   c. What could have caused the error?

2. d. -3dB point recalculated ____________

4. a. -3dB point of low pass filter ____________

   b. % error from PSpice _____________

   c. What could have caused error?

Part II:

2. c. -3dB point of op-amp Measured: _____ PSpice: _____

   % error from PSpice ____________

3. b. Maximum output voltages ____________ ____________

3. e. When does clipping occur? V_{in} = ____________ V_{out} = ____________

   Why?

3. f. How does this compare with PSpice?